

**intel[®] Ultra Low Voltage Mobile
Intel[®] Pentium[®] III
Processor featuring Intel[®]
SpeedStep[™] Technology**

Performance Brief

January 2001



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Executive Summary

The mobile Intel® Pentium® III processor is Intel's most advanced and powerful processor for notebook PCs, offering several new features for maximum performance, productivity, and manageability. With all the power needed for the next generation of Internet-enabled software, the mobile Pentium III processor will continue to deliver an exceptional experience for laptop users well into the future.

Using Intel's advanced 0.18-micron process technology, the Ultra Low Voltage Mobile Intel Pentium III processor featuring Intel SpeedStep™ Technology is offered at 500 MHz. Other Pentium III processor performance advancements include the addition of new Internet Streaming SIMD instructions, an Advanced Transfer Cache architecture, and a processor system bus speed of 100 MHz. These features are offered in a BGA2 form factor. All of these technologies make it possible to offer this outstanding performance in mobile PCs available in a variety of shapes and sizes.

The mobile Intel Pentium III processor featuring Intel SpeedStep Technology is the next dramatic step towards achieving near desktop performance. This exciting new processor has two performance modes and allows real-time dynamic switching of the voltage and frequency between the modes. This occurs by switching the bus ratios, core operating voltage, and core processor speeds without resetting the system.

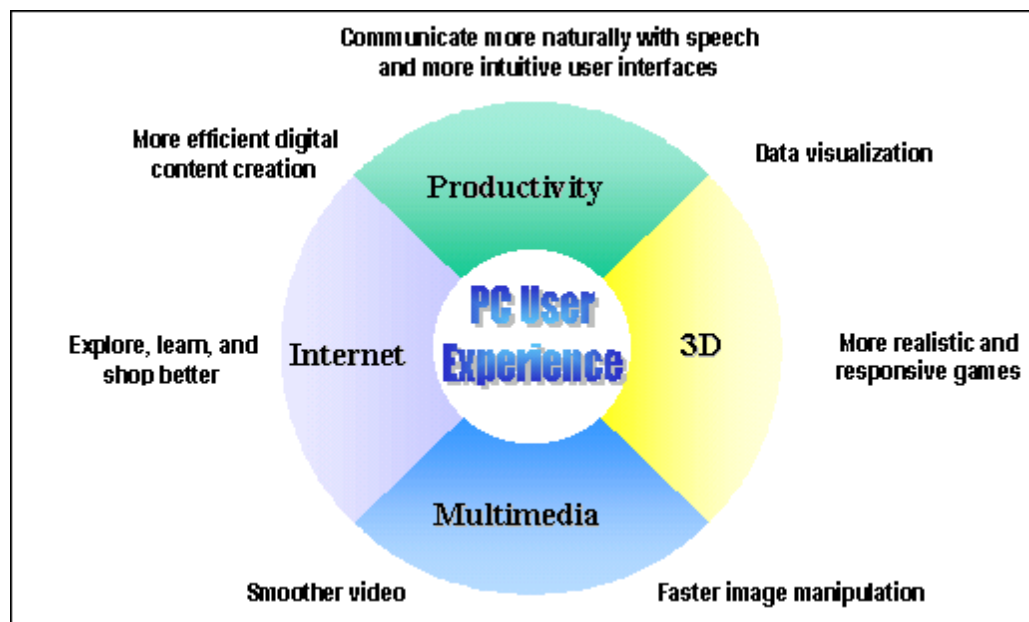
The two performance modes are the Maximum Performance mode and the Battery Optimized Performance mode. The Maximum Performance mode operates on a higher frequency and provides near desktop performance. The Battery Optimized Performance mode provides the best balance between performance and battery life and operates at a lower frequency.

The mobile Intel Pentium III processor delivers excellent performance for all PC software and is fully compatible with existing Intel Architecture-based software. The mobile Pentium III processor featuring Intel SpeedStep Technology takes laptop power into the future by offering performance headroom for business, media, communications, and Internet applications. Software designed for the mobile Pentium III processor unleashes its full multimedia capabilities, including full-screen and full-motion video, realistic graphics, and an enhanced, exciting Internet experience.

A mobile Pentium III processor used with Intel chipsets provides a proven, balanced platform from full-size notebooks to thin and light notebooks, with outstanding performance and compatibility for today's demanding applications, and plenty of headroom to remain productive for years to come. The 440BX, 440MX, 815EM Intel chipsets have the best combination of compatibility, affordability, and performance for the demands of high-performance as well as value-based laptops. Their compatibility with the mobile Pentium III processor promises to extend that track record well into the future.

Modern laptop systems are used to run a broad range of software applications. Multimedia, 3D, and Internet application use has increased, and this trend is anticipated to continue in the future. For this reason, a wide range of benchmarks should be considered when evaluating processor and system performance. PC users and buyers should consider the entire Spectrum of Performance, which includes productivity, multimedia, 3D, and Internet performance. See Figure1.

Figure 1. The Spectrum of Performance



Systems based on mobile Pentium III processors also include the latest features to simplify system management, decrease power consumption, and lower the total cost of ownership for large and small business environments. The mobile Pentium III processor offers great performance for today's and tomorrow's applications, as well as the quality, reliability, and compatibility that is expected from the world's leading microprocessor company.

This Performance Brief introduces the mobile Pentium III processor featuring Intel SpeedStep Technology, explains the technologies that make it work, examines the purpose and methods behind the industry's most useful benchmarks, and shows how the mobile Pentium III processor currently performs on each. As new benchmarks are introduced, this performance brief will be updated appropriately.



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1.0 Introduction

The mobile Intel Pentium III processor provides exceptional power for high-performance, mainstream, thin and light, mini and sub-notebooks. It offers speed, compatibility, and reliability for today's productivity, multimedia, 3D, and Internet applications on today's operating systems. In addition, new multitasking, manageability, security, and architectural enhancements make the mobile Pentium III processor the perfect choice for businesses preparing to enter the emerging Personal Enterprise Computing environment.

The new Ultra Low Voltage Mobile Intel Pentium III Processor featuring Intel SpeedStep Technology at 500 MHz delivers customizable high-performance computing on a notebook. In the Maximum Performance mode, the notebook can run the most complex business and Internet applications with speeds comparable to a desktop system. When powered by a battery, the processing frequency lowers to the lower Battery Optimized Performance mode frequency to conserve battery life while maintaining a high-level of performance. In the Battery Optimized Performance mode, the mobile Pentium III processor featuring Intel SpeedStep Technology at 500 MHz will drop to a frequency of 300 MHz. Using manual override, the frequency can be boosted back to Maximum Performance mode when on the battery. This allows the user to customize performance.

When a mobile Pentium III processor is used in conjunction with Intel chipsets, the resulting platform provides reliable, balanced performance for today's mainstream notebook PCs, with headroom to remain productive as new applications emerge in the years to come.

This brief provides performance results for the following mobile Intel Pentium III processors at speeds of 300 MHz and above, while using Intel chipsets and running a variety of benchmarks, and comparing the results with the mobile Pentium III processor at 300 MHz:

- Mobile Pentium III processor at 300 MHz¹
- Mobile Pentium III processor at 500 MHz

When evaluating the performance of a microprocessor or system, it is important to obtain the complete performance picture. Today's PC user runs a broad spectrum of productivity, 3D, multimedia, and Internet software:

- Productivity software includes applications such as word processing, presentation, and personal finance programs.
- Multimedia software includes audio, video, imaging, and creativity applications.
- 3D software includes gaming, modeling, and simulation applications.
- Internet applications include Internet browsers, as well as 3D and multimedia Web content.

¹ The mobile Intel Pentium III processor is not offered at 300 MHz. This performance brief includes the performance at 300 MHz since the mobile Pentium III processor featuring Intel SpeedStep Technology at 500 MHz runs at a speed of 300 MHz in the Battery Optimized Performance mode respectively.

A processor and system should deliver the highest performance across the entire Spectrum of Performance including Productivity, Multimedia, 3D, and Internet.

This report provides benchmark results for the mobile Intel Pentium III processor family. Modern, industry-standard benchmarks were chosen to demonstrate capabilities across the Spectrum of Performance. The benchmarks include:

- Productivity performance can be measured using system-level benchmarks such as BAPCO's SYSmark* 2000 and Business Winstone* 2001.
- Multimedia performance can be compared with MadOnion's* Video*2000 MPEG-2 Encoding benchmark.
- 3D performance can be measured with the 3D Winbench* 2000 Processor Test.
- Java aspects of the Internet experience can be measured by BACPO's and MadOnion's* WebMark*2001.

Intel is committed to using the most robust and relevant benchmarks in characterizing the performance of its products, and Intel will adapt this mix over time as newer benchmarks are introduced into the PC market.

System performance does not depend on the microprocessor alone. Hardware and software system components—such as the operating system, the graphics and I/O subsystems, application software, and memory—may significantly affect benchmark results. For this reason, this Performance Brief illustrates mobile Pentium III processor performance on a consistent system configuration. Details of the system configuration used for the benchmarks throughout this brief can be found in Appendix A.

2.0 Spectrum of Performance

When evaluating the performance of a microprocessor or system, it is important to obtain the complete performance picture. A processor and system should deliver high performance across the entire Spectrum of Performance including Productivity, Multimedia, 3D, and Internet.

2.1 Productivity Benchmarks

Productivity software includes applications such as word processing presentation and personal finance. Popular, industry-standard productivity benchmarks include:

System Level Benchmarks:

- SYSmark* 2000.
- Business Winstone* 2001.

2.2 Multimedia Benchmark

Multimedia benchmarks are designed specifically to represent the activities of end users working with video, audio, and imaging technologies such as MPEG1*, Dolby* Digital Sound, AVI, PC imaging, and video conferencing. A benchmark that falls under this category is:

- Video*2000 - MPEG-2 Encoding.

2.3 3D Benchmarks/Floating-Point Benchmark

The most common type of 3D application today is 3D games. Benchmarks that measure processor, 3D, and floating-point performance include:

- 3D WinBench* 2000 - Processor Test.

2.4 Internet Technology Benchmark

Internet applications are evolving at a tremendous rate and include browser, 3D, and multimedia technologies. In attempting to evaluate processor Internet performance, PC users should consult the productivity, 3D, and multimedia benchmarks listed above. Additionally, some Java Internet technology benchmarks are:

System Level Benchmark:

- WebMark*2001.

2.5 Evolving and Future Benchmarks

Benchmarks evolve as a direct response to the development of new technologies and the need to evaluate them objectively. As hardware and software technologies evolve, benchmarks must also evolve to capture new capabilities accurately.

The mobile Pentium III processor represents a major step in the evolution of computing potential. Currently available benchmarks show considerable gains across the Spectrum of Performance. Since applications that take full advantage of the mobile Pentium III processor are in development, many of the existing benchmarks do not fully test the processor's new capabilities.

Currently, the 3D Winbench* 2000 Processor Test and the Video*2000 benchmark take advantage of the capabilities of the mobile Pentium III processor. As existing benchmarks are updated to support the new capabilities, and as new benchmarks are introduced, Intel will update this Performance Brief.

3.0 The Mobile Pentium III Processor

The mobile Intel Pentium III processor offers new levels of performance and productivity for today's most demanding applications and operating systems. It incorporates advanced features to take full advantage of the Wired for Management enterprise architecture and the Personal Enterprise Computing environment that will drive business productivity to new heights in the new century.

In order to achieve near desktop performance, the mobile Intel Pentium III processor featuring Intel SpeedStep Technology has two performance modes, Maximum Performance and Battery Optimized Performance. The Maximum Performance mode provides near desktop performance and runs at a higher frequency. The Battery Optimized Performance mode provides the best balance between performance and battery life and operates at a lower frequency. The user can do real-time dynamic switching between the modes. This occurs by switching the bus ratios, core operating voltage, and core processor speeds without resetting the system.

The mobile Pentium III processor introduces Streaming SIMD Extensions that include 70 new instructions for dramatically faster processing and improved output on existing and next-generation applications across the entire Spectrum of Performance. This includes advanced imaging, 3D streaming audio and video, Web access, speech recognition, new user interfaces, and other cutting-edge applications.

The mobile Pentium III processor is based on Intel's new 0.18-micron process that enables a higher level of integration while lowering both power consumption and heat dissipation. A 256-K full-speed Advanced Transfer Cache is included on the processor die itself for lower latency during cache accesses. Intelligent buffering of read/store data and a 256-bit wide cache line provide outstanding sustained concurrency and higher cache throughput, which enables higher performance. Although it contains 28.1 million transistors, the processor die is actually smaller than its predecessors are. The processor provides memory cacheability for up to 4 GB of addressable memory space. A self-reportable processor serial number gives security, authentication, and system management applications a powerful new tool for identifying individual systems.

The mobile Pentium III processor is available in a BGA2 form factor for high-volume availability, improved handling protection, and compatibility with the high-performance processors of the future. Compatibility with the widely deployed Intel chipset platforms also ensures compatibility with existing systems and a short qualification cycle for maximum return on investment.

The mobile Pentium III processor is backed by over 25 years of Intel experience in manufacturing high-quality, reliable microprocessors.

4.0 Mobile Pentium III Processor Product Feature Highlights

The mobile Pentium III processor is fully compatible with an entire library of PC software based on operating systems such as MS-DOS*, Windows* 3.1, Windows for Workgroups* 3.11, Windows* Millennium, Windows* 98, Windows* 95, OS/2*, UnixWare*, SCO UNIX*, Windows* NT, Windows* 2000, OPENSTEP*, and Sun Solaris*. Architectural features of the mobile Pentium III processor include:

- **Intel SpeedStep Technology:**

The Ultra Low Voltage Mobile Intel Pentium III processor featuring Intel SpeedStep Technology is offered at 500 MHz. Highlights of this technology include:

 - ⇒ Two performance modes - Maximum Performance mode for near desktop performance, and Battery Optimized Performance mode for lower power consumption and improved battery life.
 - ⇒ Real-time dynamic switching between the two performance modes without resetting the system.
- **Streaming SIMD Extensions:**

The Streaming SIMD Extensions consist of 70 new instructions, including single instruction multiple data floating-point, additional SIMD integer, and cacheability control instructions. Some of the technologies that benefit from the Streaming SIMD Extensions include advanced imaging, 3D, streaming audio and video, and speech recognition applications. The benefits include:

 - ⇒ Higher resolution and higher quality image viewing and manipulation
 - ⇒ High quality audio, MPEG2* video, and simultaneous MPEG2 encoding and decoding
 - ⇒ Reduced CPU utilization for speech recognition, as well as higher accuracy and faster response times
- **Intel MMX™ Media Enhancement Technology:**

Intel MMX technology is designed as a set of 57 basic, general-purpose integer instructions and four data types that are easily applied to the needs of a wide range of multimedia and communications applications. Highlights of the technology include:

 - ⇒ Single Instruction, Multiple Data (SIMD) technique
 - ⇒ Eight 64-bit wide MMX technology registers
- **Dynamic Execution Technology:**
 - ⇒ Multiple branch prediction: Predicts program execution through several branches, thereby accelerating the flow of work to the processor
 - ⇒ Dataflow analysis: Creates an optimized, reordered schedule of instructions by analyzing data dependencies between instructions
 - ⇒ Speculative execution: Carries out instructions speculatively and, based on this optimized schedule, ensures that the mobile processor's superscalar execution units remain busy, thereby boosting overall performance
- **Testing and Performance Monitoring Features:**
 - ⇒ Built-In Self Test (BIST) provides single stuck-at fault coverage of the microcode and large logic arrays, as well as testing of the instruction cache, data cache, Translation Lookaside Buffers (TLBs), and ROMs.

- ⇒ IEEE 1149.1 Standard Test Access Port and Boundary Scan mechanism enables testing of the mobile Pentium III processor and system connections through a standard interface.
- ⇒ Internal performance counters can be used for performance monitoring and event counting.
- ⇒ Incorporates an on-die diode that can be used to monitor the die temperature. A thermal sensor located on the motherboard can monitor the die temperature of the mobile Pentium III processor for thermal management purposes.
- Other significant features of the mobile Pentium III processor include:
 - ⇒ High-performance Dual Independent Bus (DIB) architecture (system bus and cache bus) provides high bandwidth, performance, and scalability with future system technologies.
 - ⇒ The system bus supports multiple outstanding transactions to increase bandwidth availability.
 - ⇒ A 256-K integrated, unified, non-blocking, level-two (L2) cache improves performance by reducing the average memory access time and by providing fast access to recently used instructions and data. Performance is boosted even further through the Full Speed Advanced Transfer Cache. This L2 cache is integrated on the processor die to minimize latency during cache accesses. Intelligent buffering and a 256-bit cache bus provide superior concurrency and throughput. This processor also incorporates separate 16-K, level-one caches—one for instructions and one for data.
 - ⇒ The mobile Pentium III processor supports memory cacheability for up to 4 GB of addressable memory space.
 - ⇒ The processor is available with Error Correction Code (ECC) functionality on the level-two cache bus for applications where data intensity and reliability are essential.
 - ⇒ A pipelined Floating-Point Unit (FPU) supports the 32-bit and 64-bit formats specified in IEEE standard 754 as well as an 80-bit format.
 - ⇒ Parity-protected address/request and response system bus signals with a retry mechanism ensure high data integrity and reliability.

5.0 Performance Summary

5.1 Productivity Benchmarks

5.1.1 SYSmark® 2000

SYSmark® 2000 is a suite of application software and associated benchmark workloads developed by the Business Applications Performance Corporation (BAPCO), a non-profit consortium of leading computer industry publications, independent testing labs, PC hardware manufacturers, semiconductor manufacturers, and software publishers. SYSmark® 2000 is a tool that measures system performance on popular business-oriented applications in the Microsoft® Windows operating environment.

SYSmark® 2000 contains twelve application workloads that are divided into two categories:

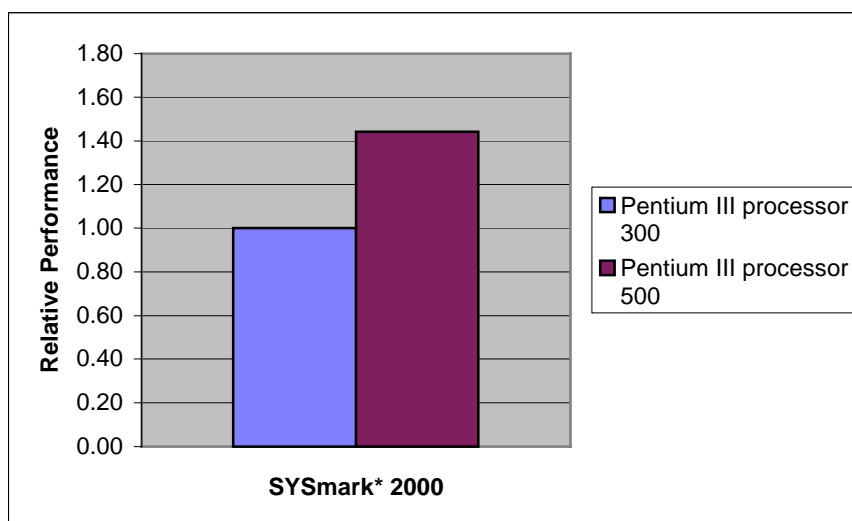
Office Productivity:

- Corel® CorelDRAW® 9.0
- Microsoft Excel® 2000
- Dragon® Naturally Speaking® Preferred 4.0
- Netscape® Communicator® 4.61
- Corel Paradox® 9.0
- Microsoft PowerPoint® 2000
- Microsoft Word® 2000

Internet Content Creation:

- MetaCreations® Bryce® 4
- Avid® Elastic Reality® 3.1
- Adobe® Photoshop® 5.5
- Adobe Premiere® 5.1
- Microsoft Windows Media Encoder® 4.0

Figure 2. Mobile Intel Pentium III Processor for SYSmark®2000 on Windows Millennium Benchmark



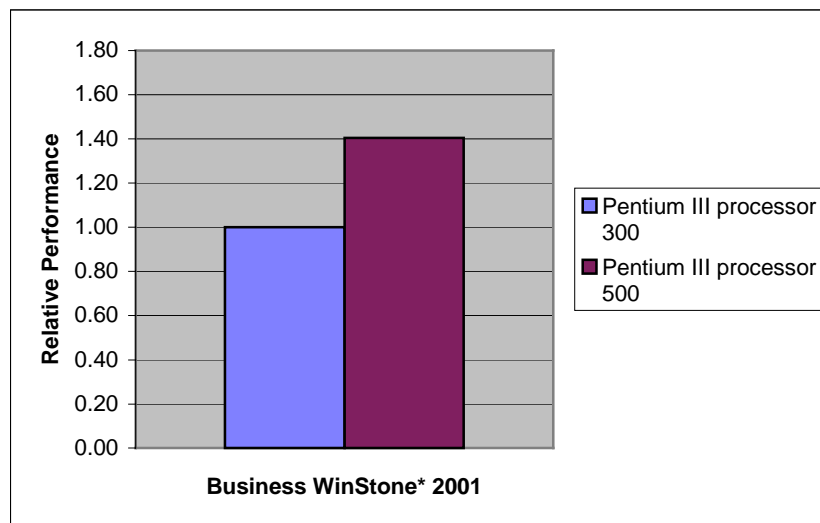
5.1.2 Business Winstone* 2001

Business Winstone* 2001 is a system-level, application-based benchmark that measures a PC's overall performance when running today's top-selling Windows-based 32-bit applications on Windows 98 SE, Windows NT 4.0 (SP6 or later), Windows 2000, or Windows Me. Business Winstone doesn't mimic what these packages do; it runs real applications through a series of scripted activities and uses the time a PC takes to complete those activities to produce its performance scores.

Here are some of the new features in Business Winstone 2001:

- an expanded range of activities and applications that better reflects the work most PC users regularly do. The benchmark now includes tests that involve project management, email, file compression, and anti-virus protection, as well as office applications and Web browsing
- a simplified score calculation
- a new testing framework that puts you in the driver's seat

Figure 3. Mobile Intel Pentium III Processor Performance for Business WinStone* 2001 Benchmark



5.2 Multimedia Benchmark

5.2.1 Video*2000 – MPEG2 Encoding

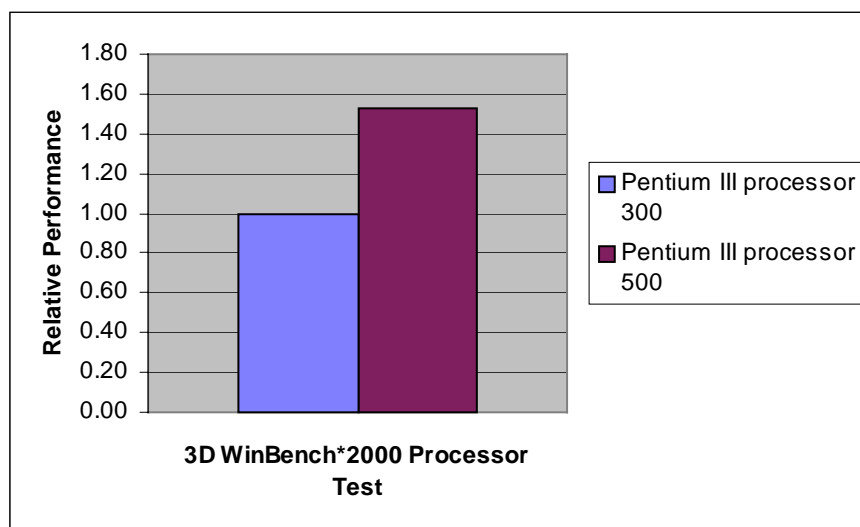
One of the components of the Video*2000 performance benchmarks, MPEG-2 encoding is used in a variety of next-generation video products like home video editing, time-shifting, and DVD creation. This benchmark assesses the CPU power available to perform software-based video compression, effects, and other tasks. *New Benchmark! Under Evaluation.*

5.3 3D Benchmarks/Floating-Point Benchmark

5.3.1 3D Winbench* 2000 Processor Test

3D WinBench* 2000 measures system-level 3D performance, including CPU and graphics subsystem performance. To understand the processor 3D performance, the benchmark suite includes the 3D WinBench 2000—Processor Test. This benchmark measures the CPU-intensive portion of the 3D graphics pipeline.

Figure 4. Mobile Intel Pentium III Processor Performance for the 3D Winbench* 2000 Processor Test

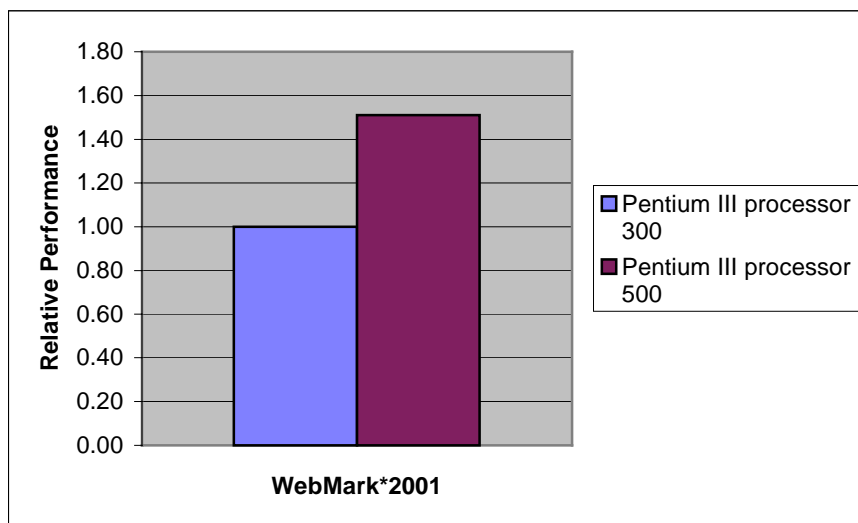


5.4 Internet Technology Benchmark

5.4.1 WebMark*2001

WebMark*2001 is an Internet benchmark designed and developed by Business Applications Performance Corporation (BAPCo) and MadOnion.com*. In addition to an Overall Score, WebMark2001 measures PC client performance across three different Internet usage models: Business-to-Business (B2B), Business-to-Consumer (B2C), and Intranet Business (B). WebMark2001 also measures the performance of the PC client on various technologies that are used within the benchmark, such as Flash (operations per second), Java (operations per second), XML (operations per second), and Video performance (frames per second).

Figure 5. Mobile Intel Pentium III Processor Performance for the WebMark*2001 Benchmark



6.0 Summary

Table 1 summarizes Productivity benchmark performance of the Ultra Low Voltage Mobile Intel Pentium III processor at speed of 500 MHz and 300MHz. A higher score indicates better performance.

Table 1. Spectrum of Performance Benchmark Results—Productivity Benchmark

	SYSmark* 2000	Business Winstone*2001
Mobile Pentium III processor 300 MHz	1.00	1.00
Mobile Pentium III processor 500 MHz	1.43	1.41

Table 2 summarizes the Multimedia benchmark performance of the Ultra Low Voltage Mobile Intel Pentium III processor at speed of 500 MHz and 300MHz. A higher score indicates better performance.

Table 2. Spectrum of Performance Benchmark Results —Multimedia Benchmarks

	Video* 2000 – MPEG2 Encoding
Mobile Pentium III processor 300 MHz	New Benchmark! Under Evaluation.
Mobile Pentium III processor 500 MHz	New Benchmark! Under Evaluation.

Table 3 summarizes the 3D/floating-point benchmark performance of the Ultra Low Voltage Mobile Intel Pentium III processor at speed of 500 MHz and 300MHz. A higher score indicates better performance.

Table 3. Spectrum of Performance Benchmark Results— 3D Benchmarks/Floating Point Benchmarks

	3D Winbench*2000 - Processor Test
Mobile Pentium III processor 300 MHz	1.00
Mobile Pentium III processor 500 MHz	1.53

Table 4 summarizes Internet benchmark performance of the Ultra Low Voltage Mobile Intel Pentium III processor at speed of 500 MHz and 300MHz. A higher score indicates better performance.

Table 4. Spectrum of Performance Benchmark Results—Internet Technology Benchmarks

	WebMark* 2001
Mobile Pentium III processor 300 MHz	1.00
Mobile Pentium III processor 500 MHz	1.51



Appendix A System Configuration

Table 5. System Configuration Used in Benchmark Tests

Processor	Ultra Low Voltage Mobile Intel Pentium III processor at 300MHz, 500 MHz
OEM's System	IBM iSeries 1124
Processor System Bus Speed	100 MHz
System Memory Size/Speed	128-MB SDRAM 100
Motherboard Chipset	Intel 440MX
Hard Disk	IBM Travelstar, Size: 20GB, Model: DJSA-220
Media	None
Operating System	Windows Millennium - Japanese
Sound	Crystal SoundFusion™ CS4281 WDM Audio
Video Controller	Silicon Motion Lynx EM+

Appendix B Average Power

The Ultra Low Voltage Mobile Intel Pentium III processor featuring Intel® SpeedStep™ Technology consumes the following average power:

Speed	Mode	Voltage	Average Power
300 MHz	Battery Optimized	0.975 V	< 0.5 W
500 MHz	Performance	1.1 V	< 1.0 W

Definitions/Data

Average power represents the power consumed by the processor while running typical office applications by an average user. Average power is measured by running industry standard benchmarks, such as Ziff-Davis* BatteryMark* 3.0.

Configurations

Average Power of Intel processors were measured on an OEM notebook with the following configuration: 128MB SDRAM, Intel 440MX chipset, 15" TFT active matrix display, Silicon Motion Lynx AGP graphics controller with 4MB video RAM, 20GB IBM TravelStar* disk drive, 3.5" floppy drive, Phoenix* BIOS, Windows* Millennium, ACPI enabled. Average power measured by running Ziff-Davis* BatteryMark 3.0. The measurements were taken at normal room temperature.

Disclaimer

Power measurements are generally taken by running certain performance and/or battery life benchmarks on a specific computer system. Different measurements can be designed to approximate the various power characteristics of a component such as a processor, or of a computer system. Some of the often-measured power characteristics include thermal design power (or TDP) and average power. Examples of benchmarks used to measure power include: Ziff-Davis* BatteryMark* 3.0 and BAPCo* SYSmark* 2000. Each processor's or system's power characteristics is measured using a particular computer system with specific hardware and software configuration. Such processors or computer systems may or may not be commercially available at the time when the measurements are taken but reasonable effort is made to make such measurements on processors and computer systems currently or soon-to-be commercially available. Where non-commercial systems are utilized for power measurements due to special instrumentation needs, reasonable effort is made to ensure that such non-commercial systems have characteristics, configurations, and properties similar to those of a computer system currently or soon-to-be commercially available, although such similarity cannot be guaranteed. Actual power measurement results may vary depending on the specific hardware and software configuration of the computer system measured, the power characteristics of those computer components not under direct measurement, variation in processor manufacturing processes, the benchmark utilized, the specific ambient condition under which the measurement is taken, and other factors. Buyers should consult other sources of information to evaluate the power characteristics of the systems they are considering purchasing. For more information about power characteristics (such as TDP or average power), and a description of the systems and microprocessors used in the power measurements, and any other information about processor and system performance and power benchmarks, visit Intel's World Wide Web site at <http://developer.intel.com/design/mobile/perfbref/> and follow the appropriate links.

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